A LETTER TO A Member of Parliament, CONCERNING *DAGENHAM-BREACH*: Occasion'd by the late Ruin of the Works there.

By *Joseph Gillmore*, Mathematician.

London, Printed in the Year MDCCXVIII.

A LETTER

TO A

Member of Parliament,

CONCERNING

DAGENHAM-BREACH:

Occasion'd by the late Ruin of the Works there.

By *Joseph* GILLMORE, Mathematician.

LONDON, Printed in the Year MDCCXVIII.

A LETTER TO A Member of Parliament.

SIR,

ACCORDING to your Requeſt I have Mathematically conſider'd the Nature of Dams, with the Accidents which lately befel the Works at *Dagenham-Breach*: And as I have writ nothing but what is ſupported by Demonſtration, it is on that Foot only I deſire your good Offices in the Houſe, towards introducing this Scheme into Practice, and encouraging the Author of it, in Matters which are to carry their *Recommendation* in their *Uſefulneſs* only. I ſhall not delay you with farther Preamble, but proceed to an Explanation.

Whoſoever undertakes a Work of this Nature, ought to be well vers'd in Mechanick Powers, which (tho' no ſmall Branch of the Mathematicks) is generally overlook'd as trivial: For this Reaſon, Workmen often miſcarry in the moſt important Buſineſs, and, (after the Expence of large Sums) have fail'd, without being able to ſhew the leaſt Reaſon for their Miſcarriage. But not to enter upon a Detail of Imperfections, I ſhall proceed to ſhew the true Pro-

LETTER

TO A

Member of Parliament,

CONCERNING

DAGENHAM-BREACH:

Occasion'd by the late Ruin of the Works there.

By Joseph Gillmore, Mathematician.

LONDON, Printed in the Year MDCCXVIII.

A LETTER TO A Member of Parliament.

SIR,

ACCORDING to your Requeſt I have Mathematically conſider'd the Nature of Dams, with the Accidents which lately befel the Works at *Dagenham-Breach*: And as I have writ nothing but what is ſupported by Demonſtration, it is on that Foot only I deſire your good Offices in the Houſe, towards introducing this Scheme into Practice, and encouraging the Author of it, in Matters which are to carry their *Recommendation* in their *Uſefulneſs* only. I ſhall not delay you with farther Preamble, but proceed to an Explanation.

Whoſoever undertakes a Work of this Nature, ought to be well vers'd in Mechanick Powers, which (tho' no ſmall Branch of the Mathematicks) is generally overlook'd as trivial: For this Reaſon, Workmen often miſcarry in the moſt important Buſineſs, and, (after the Expence of large Sums) have fail'd, without being able to ſhew the leaſt Reaſon for their Miſcarriage. But not to enter upon a Detail of Imperfections, I ſhall proceed to ſhew the true Pro-

portion and Difference between Weight and Power, and upon this Rule ground my preſent Undertaking.

Suppoſe a Dam to be 20 Foot high, and but 1 broad, and allow 64.25 Pounds Averdupoiz Weight to a Cubick Foot of Salt Water; there is no more Weight of Salt Water preſſing againſt it than the Triangle, whoſe Baſe is of the ſame Length as the perpendicular Height of the Dam.

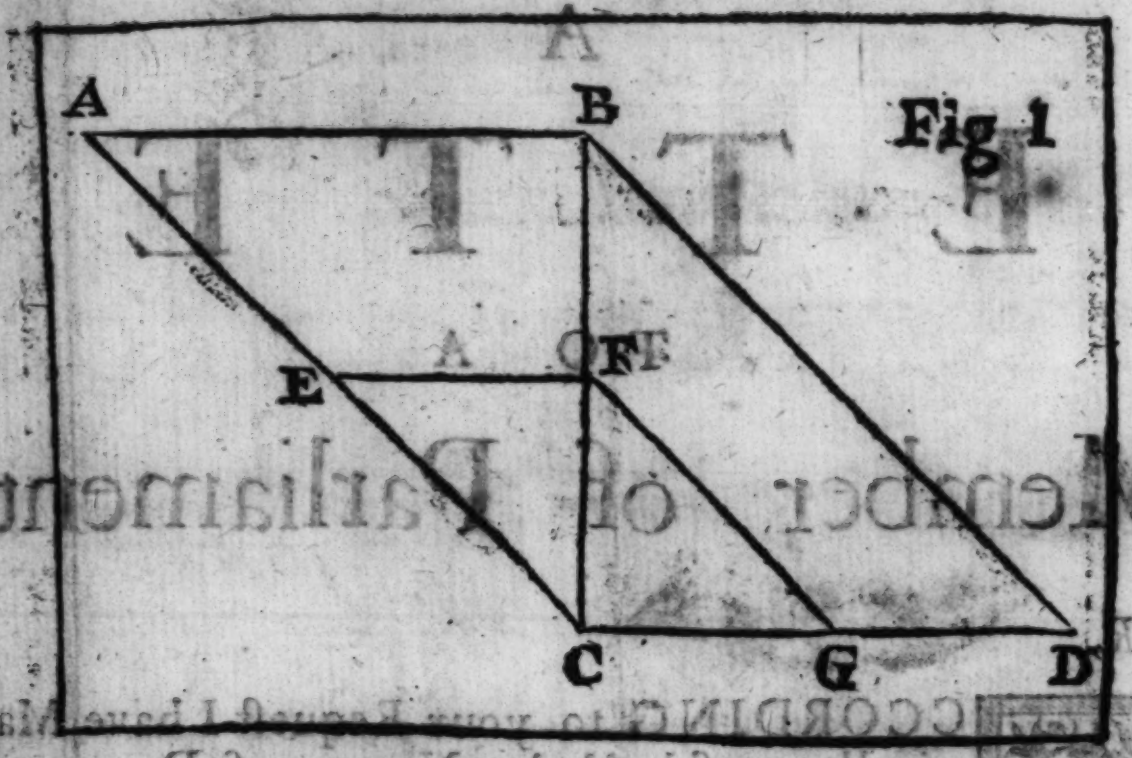


Fig 1

As in Fig. 1. Let CB be the Dam 20 Foot high, and 1 Foot broad, the Triangle of Water ABC meaſures 200 Cubick Feet, which multiply'd by 64.25, the Product is 12850 Pound, or 5 Tuns, 14 Hundred, 2 Quarters, and 26 Pound; now, the Support, to reſiſt ſuch a Weight, ought to be equal to the Triangle of Water CBA, as CBD: Or if but 10 Foot high, to the Triangle of Water CFE, as CFG; and ſo of any other Height. But the ſaid Weight of 5 Tuns, 14 Hundred, 2 Quarters, and 26 Pound, is very inconſiderable to what really preſſes againſt ſuch a Dam, as was calculated to every Inch in 20 Foot high, (whoſe Center of Gravity lieth in the Middle of every Inch) and contracted into Feet, as in the Table following:

A TABLE, ſhewing the Weight of any Quantity of Water, from 1 Foot to 20 Foot high and 1 Foot broad. Againſt it, the real Weight, according to the Laws of Nature, that Matter always preſſes downward, endeavouring to a State of Reſt, and encreaſeth its Weight according to the Diſtance of the Power from the Center of Gravity.

Feet.	Tuns.	Hunds.	Quts.	Pounds.	Tuns.	Hunds.	Quts.	Pounds.
01	00	00	01	04——000	01	00	14	
02	00	01	00	17——000	17	00	20	
03	00	02	02	09——003	00	02	25	
04	00	04	02	10——007	05	02	13	
05	00	07	00	19——014	05	02	10	
06	00	10	01	08——024	14	01	22	
07	00	14	00	06——039	05	03	12	
08	00	18	01	12——058	13	02	15	
09	01	03	00	26——083	11	02	06	
10	01	08	02	20——114	13	01	16	
11	01	14	02	23——152	12	00	12	
12	02	01	01	06——198	03	00	08	
13	02	08	01	25——251	19	00	26	
14	02	16	00	24——314	14	01	11	
15	03	04	02	04——387	02	00	19	
16	03	13	01	20——469	16	02	04	
17	04	02	03	16——563	12	01	11	
18	04	12	03	22——669	02	03	16	
19	05	03	02	07——787	01	00	00	
20	05	14	02	06——917	19	01	15	

Suppoſe you would know what Weight of Sea-Water will preſs againſt a Dam of 10 Foot high. Againſt 10 Foot is 1 Tun, 8 Hundred, 2 Quarters, and 20 Pound, which is the Weight of the Quantity of Water in a Triangle of that Height; but the real Weight, according to the Diſtance of Power from the Center of Gravity C in Fig 1, is 114 Tuns, 13 Hundred, 1 Quarter, and 16 Pound: And if 20 Foot high, the Quantity of Water in the Triangle, weighs 5 Tuns, 14 Hundred, 2 Quarters, and 26 Pound; but the real Weight preſſing upon the Center of Gravity, is 917 Tuns, 19 Hundred, 1 Quarter, and 15 Pound;

Pound; but if the ſaid 20 Foot had been drawn cloſer than Inches, the Weights had been ſtill the more, becauſe the Weight being in the Form of a Triangle, or Priſm, from the Center of Gravity C, it always increaſeth on the Power; which is a great Diſadvantage to Works of this Nature, and apt to miſlead thoſe that do not underſtand it, as will be prov'd in its proper Place.

By this we may ſee what a large Increaſe of Weight either Height or Length make, and how the Works muſt be ſecur'd accordingly; for if a Dam be but 20 Poles, or 110 Yards long, and 20 Foot deep, the Weight preſſing againſt it will be 302929 Tuns, 16 Hundred, 2 Quarters, and 22 Pound.

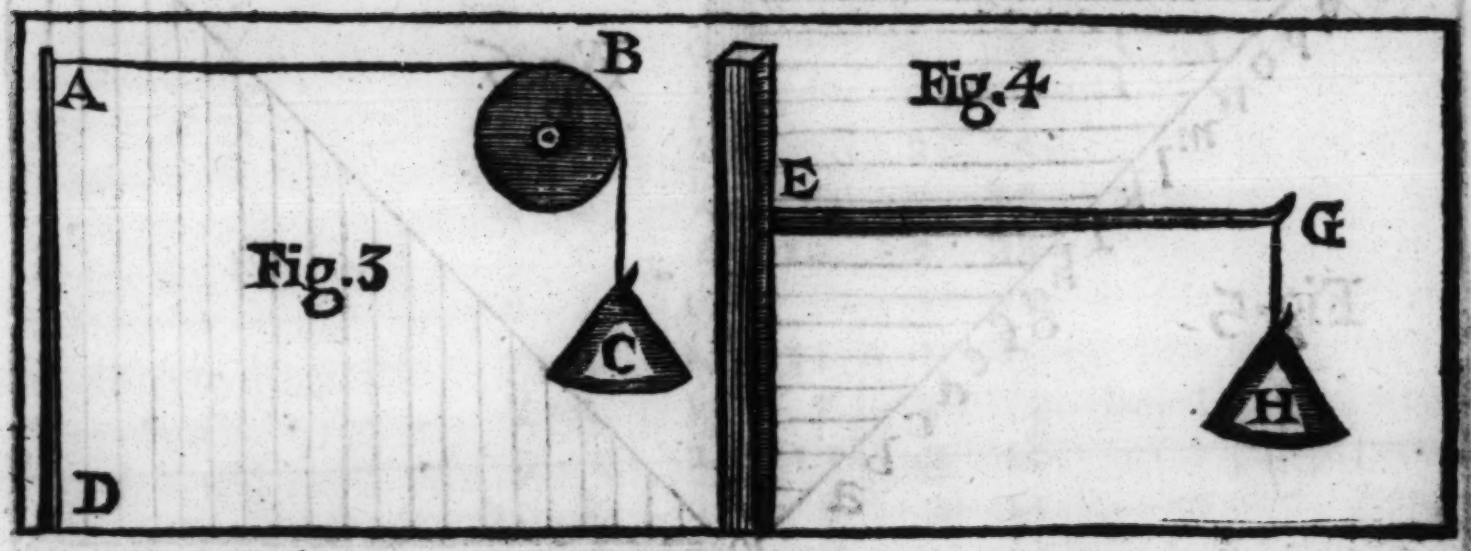
Having ſhew'd the leaſt Weight that can preſs againſt a Dam of 20 Foot high in a calm Water, the next Thing is to ſhew the Impoſſibility of a Dam ſtanding, being ſupported by perpendicular Piles, and fill'd up between with Clay, or any other Matter ſeparable by Water; and, Secondly, the true Method of making a Dam that will not only reſiſt the Weight propos'd, but any other that can naturally be imagin'd to preſs againſt it: Firſt, it is neceſſary here to ſhew the Impoſſibility of making a ſure Dam by perpendicular Piles; to prove which, let us obſerve the true Difference betwixt Weight and Power; as in Fig. 2.

Fig. 2

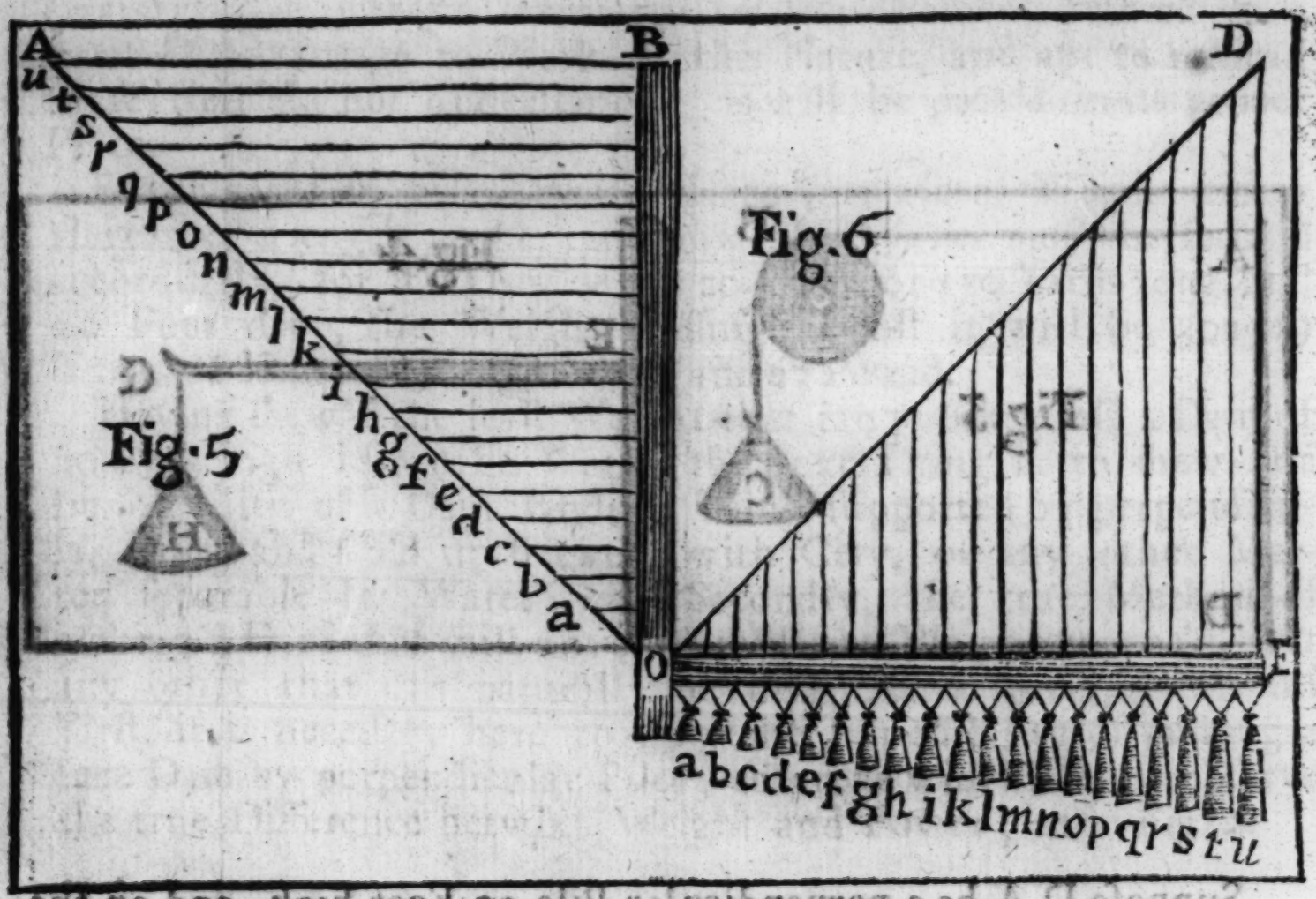
Suppoſe P O to be a Pile 20 Foot long, A is the Weight to be ſuſtain'd, C the Power to balance the Weight A; B is the Center of Magnitude or Gravity; then, let the Power at C be of the ſame Proportion to the Weight A, as the Diſtance P B is to the Diſtance B O, and the Weight at the Power C be 100 Pound: The Pile being 20 Foot from the Center of Gravity B, the Weight A muſt be 20 times the Weight of C to ſuſtain it, *viz.* 2000 Pound.

The

Weight hath the ſame Power over a Pile, whether it be perpendicular or horizontal, as appears by Fig. 3 and 4.



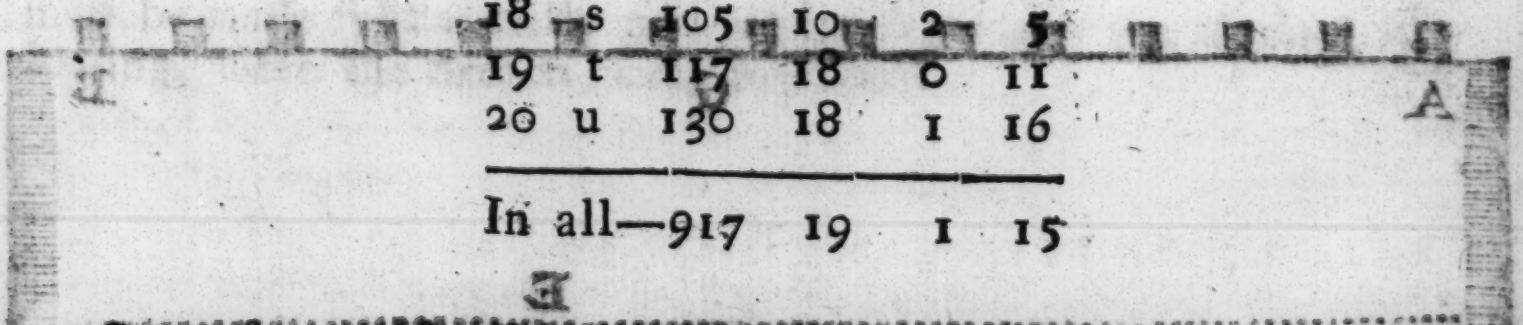
Suppoſe D A be a perpendicular Pile 20 Foot high, and on the Top at A is faſtened a Line, and convey'd over the Pully B with 100 Pound Weight at the End of it, as C. Fig. 4, let E G be likewiſe a Pile lying horizontally 20 Foot long, and hang 100 Pound Weight at G, as H; now, altho' D A be a perpendicular Pile, in Fig. 3, the Weight C hath the ſame Power at A as the Weight H hath at G, ſo by conſequence, on the Centers of Magnitude, D and E, in Fig. 3 and 4, muſt be 2000 Pound Weight, as before.



The next Thing I ſhall do, is to conſider the Weights apart between every Foot, as in the Triangle of Water A B O in Fig. 5. where the Pile O B ſtands perpendicular; and in Fig. 6, as in the Triangle O D E, where the Pile O E lieth horizontally, both loaden with the ſame Triangle of Water, as in the Table following.

A TABLE, *ſhewing the Weight of every Lead, mark'd by ſmall Letters, from the Center of Gravity* O, *in Fig.* 5 *and* 6, *from* 1 *Foot to* 20 *Foot high and* 1 *Foot broad.*

Feet.		Tuns.	Hunds.	Quts.	Pounds.
1	a	0	2	1	4
2	b	0	16	0	5
3	c	2	3	2	5
4	d	4	4	3	15
5	e	6	19	3	24
6	f	10	8	3	12
7	g	14	11	1	19
8	h	19	7	3	3
9	i	24	17	3	18
10	k	31	1	3	11
11	l	37	18	2	24
12	m	45	10	3	24
13	n	53	16	0	18
14	o	62	15	0	13
15	p	72	7	3	8
16	q	82	14	1	13
17	r	93	15	3	7
18	s	105	10	2	5
19	t	117	18	0	11
20	u	130	18	1	16
In all—		917	19	1	15



Suppoſe, as aforeſaid, a Pile of 20 Foot long, and a Foot broad, either perpendicular, or horizontal, as O B, or O E, and Weights hung in the Center of every Foot, repreſenting the Weight of Water preſſing againſt ſuch a Dam, as the Triangle O D E; the Weight (a) at 1 Foot will be 2 Hundred, 1 Quarter, and 4 Pound; the Weight (b) at 2 Foot, is 16 Hundred, and 5 Pound; and ſo of the reſt, as in the Table, and referr'd to the Triangle

Triangle aforeſaid; but the laſt Weight (u) at 20 Foot Diſtance, is 130 Tuns, 18 Hundred, 1 Quarter, and 16 Pound; ſo by conſequence, add all the Weight together, as in the Triangle Fig. 6. a, b, c, d, *&c.* or as in the Table, the Total will be 917 Tuns, 19 Hundred, 1 Quarter, and 15 Pound, lying upon the Center of Gravity O; and the very ſame Preſſure as the Weight aforeſaid lieth againſt the Dam OB in Fig. 5, cauſed by the Triangle of Water A O B, and divided into Feet, and mark'd with Letters a, b, c d, *&c.* repreſenting the ſame Quantity as the Weight in the Triangle O D E in Fig. 6. By this it is plain, that as the Height of the Dam increaſeth, if but a ſmall Matter, the Power increaſeth prodigiouſly on the Center of Gravity O, which makes it almoſt impoſſible that a Dam of any conſiderable Height ſhould ſtand, being ſupported by perpendicular Piles, although drove in never ſo deep, becauſe ſuch an incredible Weight as almoſt 918 Tuns, preſſes directly upon the Center of Gravity O, as in the Triangle aforeſaid, and the Dam but 1 Foot broad and 20 Foot high. But this is not all the Illconveniency and Abſurdity that attend Works of this Nature; for, at the firſt ſetting out, or the very Moment they begin to fill up the Trench (prepar'd with Piles and Plank) with Clay, or other Matter ſeparable by Water; I ſay, from that very Moment they begin to work the Deſtruction of the whole Dam; and the higher they go, the weaker it is, as is demonſtrated in Fig. 7.

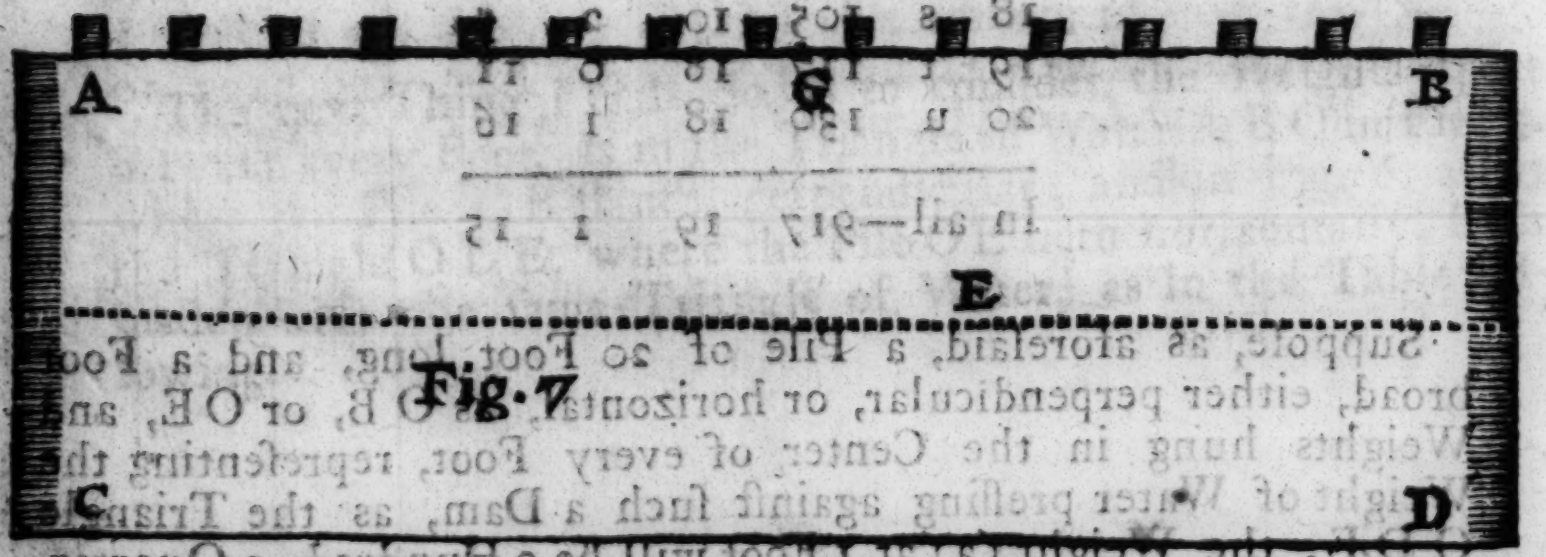


Fig. 7

Suppoſe Piles were fix'd, and plank'd on both Sides, from one Side of the Breach to the other, as A B C D, and filPd up with Clay,

Clay, or any Thing elſe, muſt, retain in its Cavities a Body of Air, which will ſink with it when thrown into the Water; and as more Weight is ſtill preſs'd upon the ſaid Cavities under Water, it muſt of Neceſſity force out the Air retain'd in them, and cauſe the Clay, ſo mix'd, to be ſlippery and unſound at Bottom, and conſequently very unfit to be the Foundation of ſo great a Work, while all the Weight (tho' never ſo much) above High-Water-Mark, is only an Addition to its Deſtruction.

In Fig. 7, let E be High-water-Mark on a Nip-Tide 8 Foot; the ſaid 8 Foot (or more, if the Water riſes higher) being but Slime or Mud, or at leaſt, ſo mix'd with Water, all the dry Clay from E to G being preſs'd by the great Weight of Water on a high Tide, and ſupported only by a ſlabby Subſtance, muſt add ſo many thouſand Tuns more to the Center of Gravity at the Bottom of the Piles, to haſten its Ruin, when once the back Water is drawn off: For, force out the Air by well ramming it, when but damp, or juſt moiſt, it will retain its Texture pretty well, but if once broken into Parts, and mix'd with Water, is but a Slab. From theſe very Defects I have twice foretold the Ruin of this Work, and do humbly conceive there can be no Method more proper for its Subſiſtance than what I have laid down.

The next Thing to be conſider'd, is, how to build a Dam ſtrong enough (when the Breach lies, perhaps, 10, 20, or 30 Foot under Water) to reſiſt ſo prodigious a Weight as is mention'd in the foregoing Table; the which, I humbly preſume, may be made ſubſtantially firm under Water, in the Manner following, were the Breach never ſo broad.

The Difference between a perpendicular Pile, and one ſupported by a Hypothenuſe or Prop.

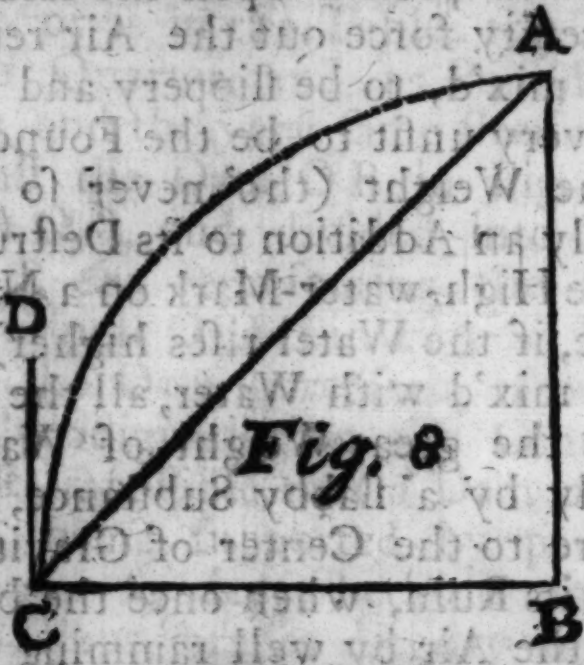


Fig. 8

In Timber-work, the greateſt Reſiſtance againſt any preſſing Weight, muſt be done by a Triangle, whoſe Prop, or Hypothenuſe, is the Root of the Squares of the perpendicular Pile A B, and the Baſe B C added together; that is, if A B be 20 Foot, and B C 20, then C A muſt be 28.2 Feet, which will form an Angle at the Baſe and Perpendicular of 45 Degrees; in which Poſture a Prop well fix'd will reſiſt the greateſt Weight or Force that can poſſibly preſs againſt it.

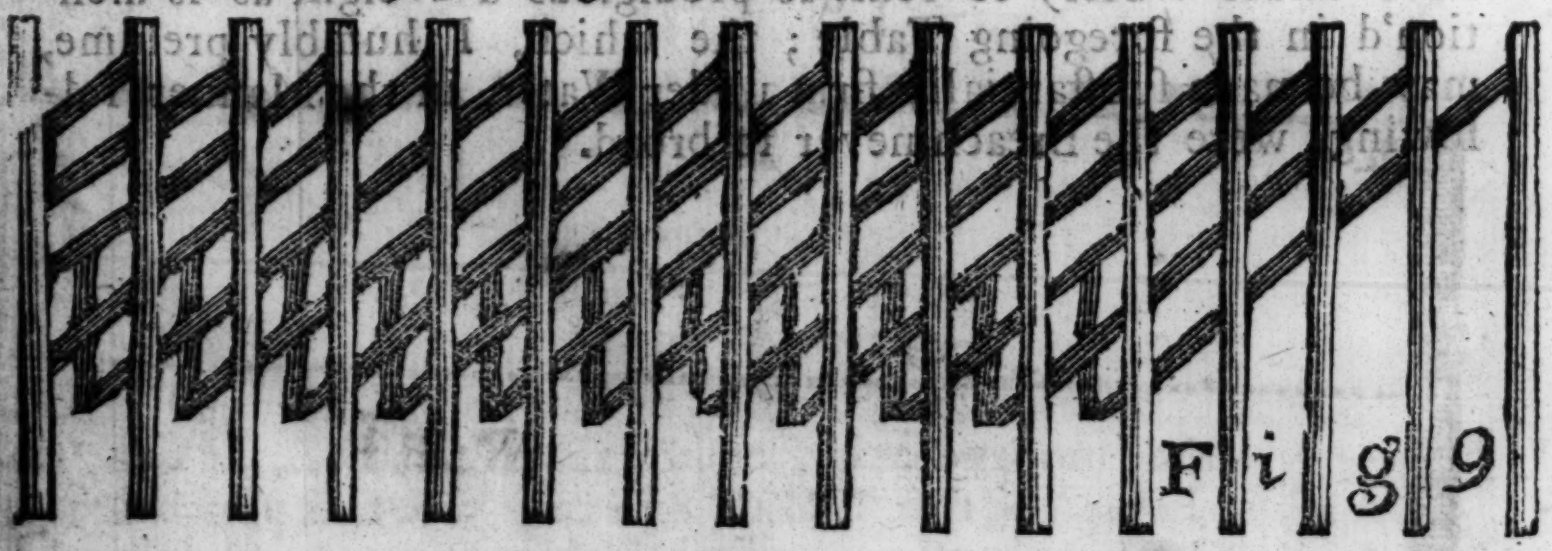


Fig. 9

The firſt Thing in ſuch a Work is to fix the Piles, by being forc'd down as deep as convenient, about 3 or 4 Foot diſtance one from the other, and their Props equal to the Hypothenuſe A C

in

in Fig. 8, one End to be faſten'd to the Top of the Pile at A, and the other againſt the Bottom of a ſhorter Pile, as C D, which I conceive cannot poſſibly ſlip, becauſe the Angles A and C being equal, the whole Weight preſſeth directly upon the Prop A C, and is ſtopp'd in the Bottom by the ſhort Pile C D, ſo that it is as impoſſible thoſe Parts ſhould preſs one into the other, as, by fixing the greateſt Weight upon a perpendicular Pillar, you ſhould preſs the Parts of the ſaid Pillar into itſelf. This is prov'd by Fig. 9, and needs no farther Explaination.

The Piles, with their Props, being fix'd, the next Thing is, to build Cheſts of 10, 15, or 20 Foot long, and 8 or 10 Foot broad, as the Dam ſhall require, with their Bottom and Side Braces, and Braces every 2 Foot deep from Side to Side, well duſtail'd in, to keep them from ſpreading: They need not be plank'd above 10 Foot high, and well caulk'd (as Cheſt C); then launch it, and fix it before the Piles, and drive down before it 2 or 3 Piles, only to keep it ſteady, as in Fig. 10. Cheſt D; when this is done, put into it ſo much Clay, well ramm'd, as will ſink it within 2 Foot of the Top, which, if 20 Foot long, and 10 broad, will take up about 50 Tuns, and 9 Hundred of Clay, and will riſe and fall always with the Tide, that the Water may have a free Paſſage under it; *See Fig.* 11.

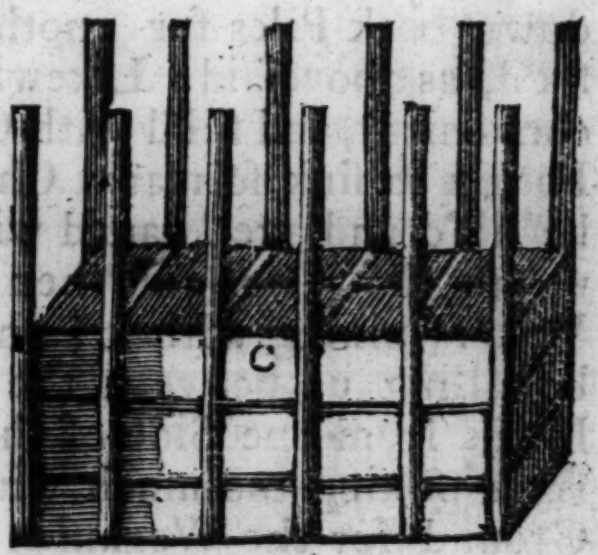
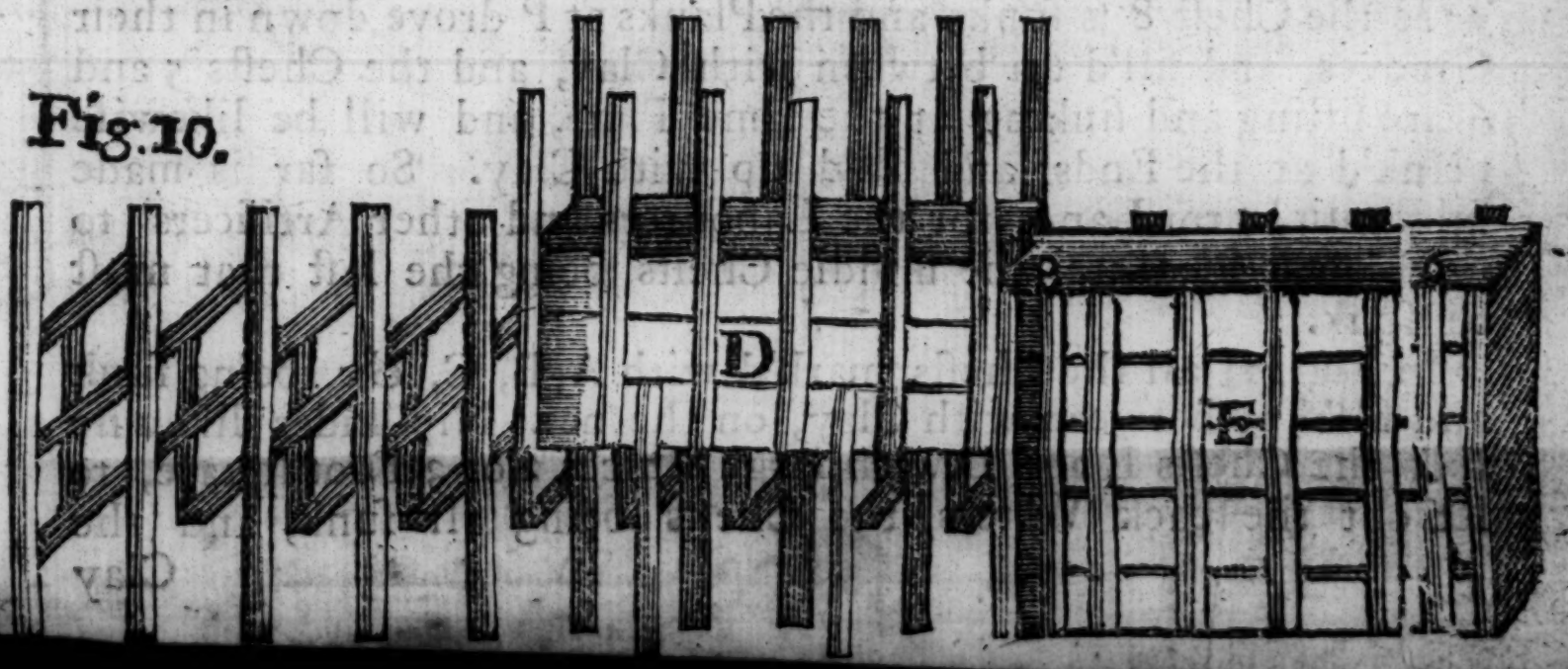


Fig. 10.



Having ſhew'd before how the Cheſts are to be built, launch'd, and fix'd in their Places, in order to be ſunk: The next Thing I ſhall treat of, is, how the Dam muſt be begun and ended, and then conſider its Power of Reſiſtance, and Impoſſibility of Ruin. Firſt, after the back Piles, with their Props, are fix'd as they ought to be, I propoſe 2 Rows of Cheſts (or more, if Occaſion be) plank'd and well caulk'd, about 8 or 10 Foot, according to the Height of the Water, and not one of them to be quite ſunk, but to float every Tide, for a free Paſſage of the Water, as aforeſaid. The firſt Row to lie cloſe before the back Piles, and 2 or 3 Piles drove in before them to keep them ſteady; then 8 or 10 Foot forward, as from A to B, leave a Space, and drive down back Piles for another Row of Cheſts before them to be fix'd, as aboveſaid: Likewiſe having prepar'd ſo many Cheſts as convenient, and fill'd with Clay 4 Days before the Tides are nipp'd, I begin to ſink ſo many Cheſts at both Ends of the Breach, as can be fill'd and well ram'd with Clay, and plank'd and brac'd quite up to the Top, and then to be ſure you are ſecure from any Water mixing with it; and while this is doing, Labourers may be filling up between the Cheſts, having made Partitions with Plank from one Side of the Cheſts to the other, to ſtop the Clay from mixing too much with the Water, then there will be firm Ground for the Workmen to go over on every Nip-Tide to fill the other Cheſts, as in Fig. 11, where 1, 2, 3, 4 on one End of the Breach, and 9, 10, 11, 12 on the other End of the Breach were Cheſts quite ſunk, and fill'd up the laſt Nipping Tides, and all the Trench between them fill up from O to O on one End, and from O to O on the other End of the Breach. At this Nip-Tide the Cheſt 8 is ſunk, and the Planks at P drove down in their Grooves, and fill'd up between with Clay, and the Cheſts 5 and 6 are filling and ſinking at the ſame Time, and will be likewiſe plank'd at the Ends, and fill'd up with Clay. So far is made ſubſtantial firm Land, for the Labourers and other Artificers to work on at Pleaſure, the middle Cheſts being the laſt that muſt be ſunk.

In Fig 12, all the Cheſts mark'd with A, B, C, *&c*, being ſunk and fill'd up between with Clay, on the next Nip-Tides likewiſe ſink the Cheſts E and D with large Sluices 2 or 3 Foot ſquare, to let out the back Waters, the Cheſts being all ſunk, and the

Clay

Fig. 11.

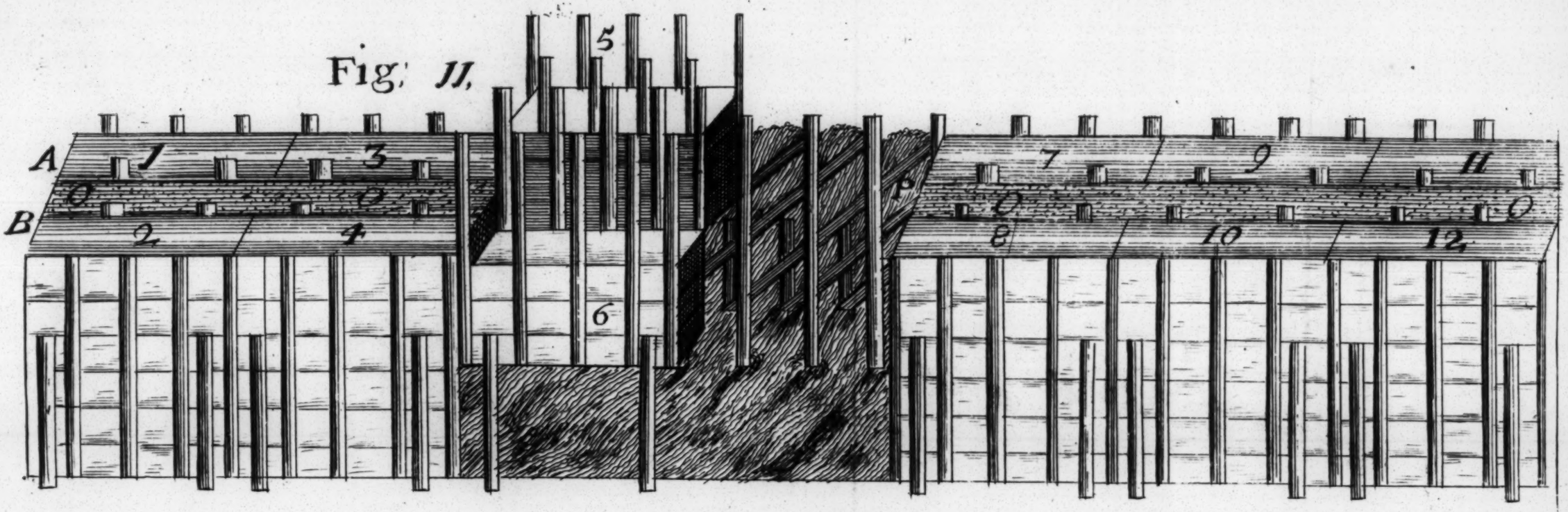
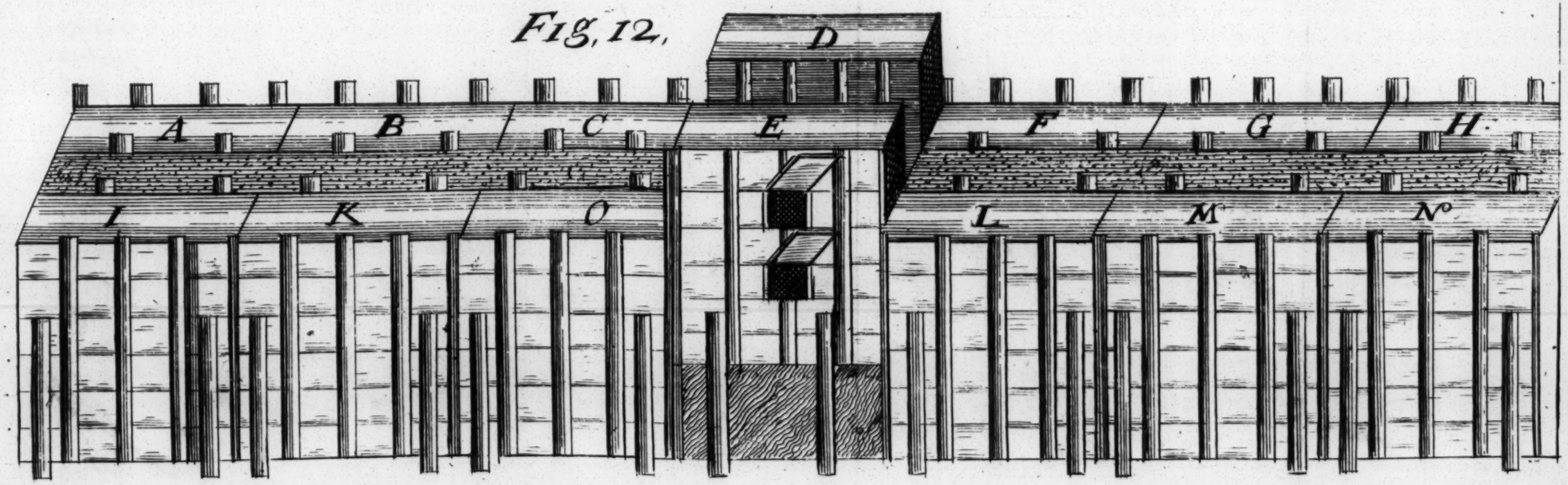


Fig. 12.



Clay well ramm'd down to the Bottom, the next Thing to be conſider'd is the Strength of the Dam according to the Weight of the Clay in the Cheſts; for the real Gravity of all Bodies preſſeth downwards proportionably to the Quantity of Matter in that Body, (which is call'd Weight) or rather, endeavours to deſcend when reſiſted. The Dam propos'd is 600 Foot long, 30 broad, and 20 deep; meaſures 360000 cubick Feet, and weighs almoſt 20652 Tuns: And although the Priſm of Water be 20 Foot high, and 20 on the Baſe meaſures 120000 cubick Feet, and weighs almoſt 3442 Tuns, which proves there is ſix times the Weight of Clay as Water; but then conſidering when Water is ſtopp'd, or reſiſted, it will ſpread and preſs horizontally, and according to the Diſtance of Power from the Center of Gravity, as in the Table at the Beginning, at 20 Foot high, and one Foot broad, the Preſſure on it is almoſt 918 Tuns; then on a Dam of 600 Foot long, muſt be near 550800 Tuns; which if you divide by the Weight of Clay in the Dam, *viz.* 20652 Tuns, ſheweth there is almoſt 27 times more Weight and Power of Water than Clay. This extraordinary Difference being what (I preſume) was never yet calculated, is the Reaſon ſo many great Works have been broke down, and the Undertakers ruin'd; eſpecially conſidering the Body of Clay on the Slab, endeavouring to preſerve it ſelf either in Motion or Reſt, being preſſed by the Priſm of Water againſt it, adds ſo much more Weight to the Power of the Water upon the Body of the Dam, it muſt of neceſſity overſet and ruin any Work ſupported only by perpendicular Piles: But in the Method here laid down, the Clay being wrought only damp, is made ſolid to the Bottom; the Texture being preſerv'd by the Cheſts, as aforeſaid, and the back and fore Piles ſupported by ſtrong Props but 3 Foot aſunder, and in the ſtrongeſt Poſition, no preſſing Weight in Nature can hurt it, let the Storm be never ſo great.

The Sluices will alſo be found of great Advantage to the Country, in filling up the low Lands, ſunk by the ebbing and flowing of the Tides; as ſuppoſe a ſmall Quantity, but 40 Poles ſquare, to be made good by the Sediment or ſettling of the back Waters flowing through the Sluices, the ſaid Quantity of Land meaſures

1600 ſuperficial ſquare Poles, or 36300 cubick Feet, at one Inch deep, and (according to the common Computation, that Clay is twice as heavy as Water) will weigh 2082 Tuns, and allowing a Dung-Cart to hold a Tun, muſt be 2082 Loads to raiſe the ſaid Land 1 Inch; then allowing 6 Days to carry the Clay or Earth, there muſt be 347 Carts employ'd to do it in the ſaid 6 Days: Now, by this Method, every Tide coming through the Sluices will leave a large Sediment behind it; and when the Sediment of the ſtill Water behind the back Cheſts is rais'd ſo high as the Bottom of the lower Sluice, that may be cloſed faſt; and ſo up to the ſecond, third, or fourth Sluice; and when the Water is ſo damm'd up by Degrees, there is no Fear of Sediment enough to fill up more in one Week over the whole Country, than 1000 Carts can bring in a Year, and 10000 Acres is as ſoon made good as 1 Acre; but in this the Charge will be ſomething greater, becauſe the fore Cheſts muſt be ſecur'd with Props as the back Piles are: But if this Way is not uſed, after the Country is drain'd, by Trenching, or Engines, or both, build a ſtrong Wall behind the back Piles, and fill up between the Cheſts and Walls with Earth; which will not only preſerve the Piles and Props for many Years, but when rotten or decay'd will ſtill ſupport the Dam.

This Dam ought to be built at the very Mouth of the Breach, let the Water be never ſo rapid, becauſe if you contract the River to its true Current, the Rapidity of it will ſtrengthen the Tide for a long Way, and keep it clean; likewiſe, this Method may be vaſtly improv'd, to the Benefit of the Publick, for cleanſing of Roads, building of Peers for Shiping, making of Cheſts in the Form of Triangles, Geometrical Squares, Paralelograms, Rhombus, or Rhomboides, or any other Form that is moſt convenient to ſharpen the Currents, or turn it on any foul Part of a navigable River; which ſaid Cheſts may be empty'd at any Time, and apply'd to other Places.

In this Work, the Cheſts may be built in or about *London*, and floated down to the Breach, after all the back Piles are fix'd in, and on which the Artificers and Labourers may work at Pleaſure, without the Diſturbance of the Tides.

For

And for a farther Explanation of this Work, there is a Model built, wherein is artificially ſhewn the riſing and falling of the Cheſts, with the Flux and Reflux of the Tides, 'till a convenient Time be found to ſink them together: This Model is alſo a plainer Proof of its Strength, and is ready to be produc'd when requir'd; and, if, upon a ſtrict Examination, it is accepted, I will take an exact Plan of the Breach Inſtrumentally, with a Scale added to it, and write an Eſtimate of the Particulars of the whole Charge.

Thus, Sir, I have, in the plaineſt Manner, expreſs'd my Thoughts on this Occaſion, which I ſubmit to the Conſideration of all Gentlemen who have the Honour to ſit in Parliament, and am,

SIR,

Your moſt Obedient

Humble Servant.